Rapid Measurements and Mapping of Tracer Gas Concentrations in a Large Indoor Space

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ABSTRACT

Rapid mapping of gas concentrations in air benefits studies of atmospheric phenomena ranging from pollutant dispersion to surface layer meteorology. Here we demonstrate a technique that combines multiple-open-path tunable-diode-laser (TDL) spectroscopy and computed tomography to map tracer gas concentrations with approximately 0.5 m spatial and 7 second temporal resolution. Releasing CH_4 in a large (7m x 9m x 11m high) ventilated chamber, we measured path-integrated CH_4 concentrations over a planar array of 28 "long" (2-10 m) optical paths, recording a complete sequence of measurements every 7 seconds during the course of hour-long experiments. Maps of CH_4 concentration were reconstructed from the long-path data and compared with simultaneous measurements from 28 "short" (0.5 m) optical paths. On average, the reconstructed maps capture ~ 74% of the variance in the short path measurements. The accuracy of the reconstructed maps is limited, in large part, by the number of optical paths and the time required for the measurement. Straightforward enhancements to the instrumentation will allow rapid mapping of three-dimensional gas concentrations in indoor and outdoor air, with sub-second temporal resolution.

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